

**Energy efficient?** Deregulating electric utilities may provide competition and lower prices, but some wonder about the potential environmental costs.

But Gordon Hester, an energy specialist at the utility-funded Electric Power Research Institute (EPRI), cautions against such worries. EPA regulations based on modeling by the Ozone Transport and Assessment Group, an ad hoc group of EPA and state officials, industry, and environmental groups, showing that ozone travels several hundred miles may force the Midwestern utilities to reduce their NO<sub>x</sub> emissions. Hester also says the EPA's tougher proposed new ozone and particulate standards, if passed, could help curtail utility-caused emissions. But such standards would not go into effect for several years.

Deregulated electricity may also mean that factories will substitute electricity for more polluting industrial processes. For example, according to Howard Gruenspecht, an analyst studying the impact of electric utility restructuring for the Department of Energy, there has been a move in industries to replace paint drying, curing, and other

processes that use fossil fuels such as oil with alternative technologies fueled by electricity. Such replacement may reduce net emissions of NO<sub>x</sub> because electric generators are subject to more stringent emission controls than many other industrial sources. Electric-powered technologies in steel-making may also reduce pollutants such as coke emissions from coal-powered plants, according to an EPRI publication.

Another potential change is that more efficient and less polluting gas-powered plants may be built to provide electricity. Some gas-powered plants can be as much as 50% more efficient than coal-fired ones. For utilities competing with one another to provide power, such efficiency is quite important, notes Karen Palmer, an economist with Resources for the Future, a Washington, DC, think tank.

Public interest groups such as the Environmental Defense Fund are working to ensure that legislation such as the Schaefer Bill (HR 3790), which requires all states to

introduce electricity competition, and FERC regulations governing restructuring will continue to improve environmental quality, says Donald Aitken, a scientist with the Union of Concerned Scientists. Among Aitken's concerns is the need to make sure that "green power" renewable energy sources, such as wind- and water-powered sources, are encouraged.

Gruenspecht says that under the present scheme of utility regulation, consumers can't plug into green power. "In a restructured environment there may be a significant opportunity there," he says. Helme points to surveys by several electric utility companies showing that 35–70% of customers say they are willing to pay a premium for green power.

Palmer notes that while state-mandated, utility-funded, energy efficiency programs are fading out in the face of deregulation, independent businesses are likely to fill that void. However, those services, now free to

consumers, will come at a price. And the extent of such services, she says, remains a question.

## Update on Gulf War Illness

The controversy over Persian Gulf War illnesses took a new turn this past year in light of information that some veterans may have been exposed to chemical weapons. In June 1996, the Department of Defense (DoD) revealed that nerve agents may have drifted over the desert when U.S. forces blew up an Iraqi weapons depot at Khamsiyah. As the DoD has released more evidence, the frustrating search for what might be the cause of the rashes, muscle pain, fatigue, headaches, and other mysterious symptoms of sick Gulf War vets has spawned a new theory: that low-level exposures to those nerve agents may explain some of these illnesses.

Researchers investigating this theory are focusing on the effects of low, possibly repeated doses of such agents because DoD medical teams in Iraq received no reports of clinical symptoms like those expected from doses large enough to cause nerve agent poisoning. However, the notion that such slight exposures could cause health effects years later is controversial.

The nerve agents, including sarin and soman, are similar to organophosphate pesticides, which can cause subtle, delayed nervous system damage at high doses. But research on low doses of nerve agents—for example, experiments involving 1,400 soldiers at Edgewood Arsenal, Maryland, from the 1950s to the 1970s—has turned up no evidence of long-term adverse health effects. "It seems profoundly unlikely that any significant number of people would have long-term effects if they had no immediate effects," said Sanford Leffingwell, an occupational and environmental physician and a consultant in Dacula, Georgia, who is an expert in developing health standards for nerve agent exposures at military bases.

But there are relatively few studies like the one in Maryland, and some researchers point to hints that nerve agents could cause delayed damage. For example, in a 1982 report published in *Neurobehavioral Toxicology and Teratology*, a group of researchers found that industrial workers accidentally exposed to doses of sarin high enough to cause toxic effects—as well as a handful of monkeys exposed to various doses of sarin (in some cases low, repeated doses)—had slightly altered electroencephalograms a year later, though no clear connection was identified between exposures and brain function.

Neurotoxicologist Peter Spencer of Oregon Health Sciences University in



## Evolving Research

A proposal made just 44 years ago, that the structure of the DNA molecule is a simple double helix, has evolved into one of the most ambitious research projects of this century: decoding the human genome. By the 1980s, scientists realized that locating and deciphering the 50,000–100,000 genes that control human heredity would be feasible with a concerted effort, and in 1990, a cooperative agreement between researchers at the National Institutes of Health (NIH) and the Department of Energy established the framework of the Human Genome Project.

The National Human Genome Research Institute (NHGRI), which was created by the NIH to oversee its part of the project, maintains a site on the World Wide Web at <http://www.nhgri.nih.gov/index.html> that tracks the project's development and growth. From the information available via the Human Genome Project link on this page, visitors can see how improvements in technology are constantly increasing the speed and scope of NHGRI research. Advances in DNA cloning and sequencing technology, as well as the discovery of new types of genetic markers, enabled the Human Genome Project to advance ahead of schedule in the 1990s, and in 1993, the NHGRI expanded the goals that had been established in its original 1990 plan. Both the 1990 and 1993 planning documents, along with a frequently updated explanation of the project's current priorities, are available under the Human Genome Project Goals link on the Human Genome Project page.

The unexpectedly speedy progress of gene research has raised some social and ethical questions, however. Information about which diseases people are likely to develop and how they are likely to react to environmental exposures is, at least in part, contained in their genes. As scientists quickly develop the ability to decipher this information, concern has arisen over how it could be used. For example, a health insurance company could conceivably charge higher rates to a healthy woman who carries a gene that predisposes her to breast cancer. Or, an expectant mother considering a late-term abortion could be given a myriad of information about her unborn child that could affect her decision. In an attempt to address such ethical issues, the NHGRI established the Ethical, Legal, and Social Implications (ELSI) research program, whose home page is also accessible via the Human Genome Project page. Researchers in this program seek to answer questions such as how property rights laws apply to one's genome, what issues will arise in using human subjects in the project, and how the Americans with Disabilities Act applies to cases of discrimination based on a person's DNA.

Despite the ethical dilemmas uncovering genetic information may raise, many scientists contend that the benefits of understanding the human genome far outweigh the dangers. For example, with knowledge of which genes contribute to the development of certain diseases, doctors will be able to make quicker, more accurate diagnoses, even during the very early stages of a disease. In addition, new treatments and therapies may become available as a result of this information. NHGRI-supported research has already led to the identification of genes that can cause prostate cancer, Parkinson's disease, and ataxia-telangiectasia, a complex childhood neurological disorder. These and other achievements by NHGRI scientists are posted in the News, Information, and Events section of the Policy & Public Affairs site linked to the NHGRI home page. Also available here are fact sheets that summarize NHGRI research and goals. Another link on the home page, In the News, summarizes media coverage of events related to genetic research both inside and outside the NHGRI.

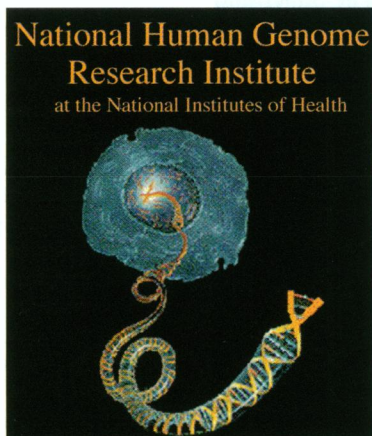
The NHGRI's coordination of the 16 genome centers around the United States has led to efficient research with less overlap, causing the project to progress quickly. In addition, the Internet has allowed scientists at each center to communicate rapidly with their colleagues in other parts of the United States and around the world, sharing data and announcing discoveries. The Genomic and Genetic Data page, linked to the NHGRI home page, contains links to databases of chromosome maps, protein structures, and maps of identified genes as well as links to research centers in France, Germany, Canada, and Japan in addition to the U.S. centers. These sites allow users to see the results of the very latest research firsthand.

Through a directory on the Intramural Research link on the NHGRI home page, it is possible to contact many of the scientists performing this research. This link offers a directory of principal researchers and advisors in the Human Genome Project and includes e-mail links. Scientists interested in undertaking research to advance the project can find information about obtaining funding from the NHGRI via the Grant Information link on the home page.

Portland, who served on a National Research Council panel that reviewed the Edgewood studies in the early 1980s, said the Army did only a "crude screening" of the soldiers that would not have picked up subtle effects. "We could not rule out the possibility of changes in sleep and brain function," Spencer said. And last January, the Presidential Advisory Committee on Gulf War Veterans' Illnesses concluded in its final report that, while stress "is likely to be an important contributing factor" to Gulf War illnesses, the government should sponsor more research on low-level exposures to chemical weapons.

The committee also recommended more studies on combinations of nerve agents and other chemicals encountered by soldiers in the Persian Gulf, such as DEET insect repellent, the insecticide permethrin, and pyridostigmine bromide (PB), a drug soldiers took to help protect themselves against nerve gas. The recommendation reflects recent findings that high dose mixtures of these chemicals can act synergistically to cause nervous system damage in chickens (see *EHP*, 103(9):792), and that stress may speed the rate at which PB crosses the blood-brain barrier (published in the 2 December 1996 issue of *Nature Medicine*). Researchers from the University of Texas Southwestern Medical Center at Dallas also recently reported in the 15 January 1997 issue of the *Journal of the American Medical Association* that 25% of a group of 249 Persian Gulf veterans had memory deficiencies, muscle pain, and other symptoms that appeared to correlate with possible exposure to specific combinations of chemicals and that 9% of the veterans had abnormal brain and nerve tests compared to healthy vets.

In search of answers, the DoD is setting aside \$27 million this year—more than double the 1996 amount—and will spend \$15 million of it on research on low-level exposures to chemicals. Some \$2 million will go for human and animal studies of the effects of nerve agents. Another \$9.5 million, tagged by Congress for nonfederal researchers only, will fund work looking for causal relationships between Gulf War illnesses and possible exposures to chemicals and drugs, including combinations. Lieutenant Colonel Karl Friedl of the U.S. Army Medical Research and Materiel Command, who is organizing the review of proposals, said the DoD is also considering





reexamining the Edgewood subjects.

The point of all this research is to uncover plausible biological explanations, said Timothy R. Gerrity, special assistant to the chief research and development officer in the Office of Research and Development of the Department of Veterans



Affairs, which is cosponsoring much of the research. Because actual exposures in the Persian Gulf may be impossible to determine, said Gerrity, "The question of causation will probably be with us for decades, if

not forever." There is also a third set of DoD-sponsored studies costing \$5 million that may matter most in the long term. The topic, says Friedl, was inspired by recent research showing that U.S. soldiers from every war from the Civil War through Vietnam have suffered a constellation of symptoms much like those of the Gulf War vets. The DoD is looking for information on the long-term effects of stress on soldiers and ways to reduce the effects, such as debriefing techniques and the use of drugs used to treat rape victims, Friedl says. "This is probably something with a high prevalence and something that we need to understand," he says, "so we don't see Bosnia War Syndrome next."

## A Decade of Cleanup Research

A woman's risk of breast cancer may depend on where she lives, according to Ann Aschengrau, associate professor of epidemiology and biostatistics at Boston University. Aschengrau is conducting a case-control study of breast cancer in Cape Cod, Massachusetts, where the incidence rate surpasses that expected from established risk factors, such as age and family history. Surprisingly, the added risk may come from vinyl-lined water pipes that, during the 1960s and 1970s, leached perchloroethylene (PCE), a common commercial solvent. Aschengrau reported preliminary results at a meeting held 23–26 February that suggest a link between PCE-contaminated drinking water and an increased risk of breast cancer.

The meeting, Superfund Basic Research

Program: A Decade of Improving Health through Multidisciplinary Research, was sponsored by the NIEHS and hosted by the University of North Carolina at Chapel Hill. The meeting attracted more than 400 research scientists, students, government officials, hazardous waste management officials, and community leaders to commemorate a 10-year partnership between the NIEHS and the EPA aimed at solving hazardous waste problems.

The Superfund Basic Research Program was established in 1986 to conduct research on the risk to humans from hazardous waste and to develop new technology to remediate contaminated sites. The February meeting was the first of its

kind to bring together scientists from diverse areas including molecular biology, toxicology, epidemiology, ecology, geology, and engineering to address problems posed by hazardous substances in the environment.

Meeting presentations, including approximately 200 poster presentations, were designed to represent different facets of the Superfund Basic Research Program. Presentations covered a wide variety of hazardous waste-related topics, from detection and correction of contamination to the impact of hazardous waste on minority and disadvantaged communities. In one presentation, Howard Hu, associate professor of occupational and environmental medicine at the Harvard School of Public Health, described his X-ray fluorescence measurements of lead in bone. "The level of lead in someone's bones tells us about that person's cumulative exposure to lead over decades," Hu said. "Our research suggests that high bone lead is a risk factor for hypertension, kidney impairment, anemia, and, among pregnant women, low birthweight in their offspring."

In many cases, however, investigators lack the necessary data to determine the health risks posed by exposure to a chemical or compound. James Sherman, senior toxicologist at Monsanto Company, said, "There will always be data gaps and uncertainty." But, he added, "It is imperative that we find better methods to quickly use current and emerging knowledge to provide best estimates of toxicity rather than simply using a series of defaults to provide

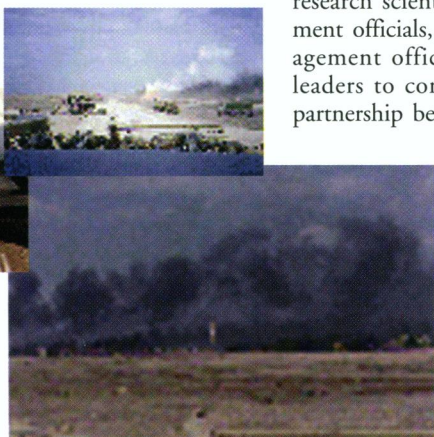
upper-bound estimates until all data gaps are filled beyond question." Sherman acknowledged that the EPA is working on this problem, and commented, "While improvements are being evaluated, we are experiencing a 'paralysis by analysis' where in the last three to five years very few new studies have been used to update [EPA-] approved toxicity criteria." He encouraged his colleagues to "get the science to the users in a usable form."

Nevertheless, Stephen Luftig, director of the EPA's Office of Emergency and Remedial Response, pointed out that many cleanup sites present complex problems—ones that require multidisciplinary knowledge, which cannot always be mobilized instantly. In addition, William Thilly, program director of the MIT Superfund Hazardous Substances Basic Research Program, warned that scientists should put high priority on proper remediation.

In addition to monitoring and risk assessment, hazardous-waste research should lead to cleanups. In some situations, nature may provide solutions. For example, Milton Gordon, professor of biochemistry at the University of Washington in Seattle, reported on the use of hybrid poplar trees to bioremediate soils contaminated with trichloroethylene and carbon tetrachloride. This approach could be widely used, Gordon added, because the more than 25 species of poplar are easy to cultivate, survive in a wide geographic distribution, and grow from 3 to 5 meters each year. Moreover, they could eventually be harvested for paper or biofuel.

Ultimately, continued research on hazardous waste may depend on Congress. Superfund legislation expired in 1994, and the tax that helped finance Superfund cleanups expired in 1995. Although proposals before Congress include funding for Superfund-related research as well as reauthorizing Superfund legislation, Congressman David Price (D-North Carolina) said, "The budget proposals are anything but a done deal, and also, reauthorization itself is an uphill battle."

Despite the uncertainty of future funding, William Suk, program director of the Superfund Basic Research Program at the NIEHS, laid out a series of challenges including training more scientists to work in the field of hazardous waste, advancing risk assessment—especially for children—and learning more about the risks from exposures to mixtures of chemicals. In addition, Suk told meeting participants, "We need to translate our research results better," by telling the public what is being done and why it matters.



**Middle East mystery.** Despite a growing cloud of controversy, researchers continue to investigate links between chemical exposures and Gulf War illnesses.

Charles Miles